ADVERTISING PAGES REMOVED

THE GLASS INDUSTRY
VOLUME 18, NUMBER 2, FEBRUARY, 1937

PERMANENT TENSILE STRESSES IN GLASS

Investigations by various workers on stressed glass have shown that glass in such a condition possesses a much greater mechanical and thermal strength than unstressed glass. This increased strength is due to the fact that the methods used (i.e., the development of a large and correct temperature gradient in the glass object while it is in the annealing range) in stressing the glass are such that the permanent stress placed in the outer surface of the glass object is a uniformly distributed compression.

If the physical nature of glass was such that the stress developed at this outer surface under the above conditions was tensile instead of compressive it would be impossible to produce the added strength required for articles such as thermally toughened plate or heat-treated pressure ware for the simple reason that it is the tensile stress developed in the outer surface of the glass object by mechanical and thermal shocks that cause the glass to fracture.

The average resistance of glass to tension is about 7 kg. per sq. mm., while the resistance to compression is over 100 kg. per sq. mm. In the case of the compression figure it is extremely doubtful if this is correct because in all compressive tests, tensile forces are present and the glass no doubt fractures due to the development of appreciable amounts of tension. In all probability the resistance of glass to compression is infinite.

With such a large difference between the resistance of glass to tension and to compression the high mechanical and thermal strength of stressed glass in which the stress exists as radial and circumferential compression is easily explained. Likewise, is the low mechanical and thermal strength of glass in which the radial and circumferential stress exists as tension.

The presence of tension either intentionally or accidentally on the outer surface of a glass object is therefore dangerous to the life of the object as it is the duty of nearly all glass articles to resist forces which will develop tension at this surface. Its presence thereby lowers the normal resistance of the glass to any usage which develops temporary tensile stresses in the outer surface of the glass. The combination of the temporary tension developed in use, through, for example, a thermal shock, with the permanent tension already existing in the object is often sufficient to cause fracture even though the tension developed by the thermal shock alone would not fracture a strain free article.

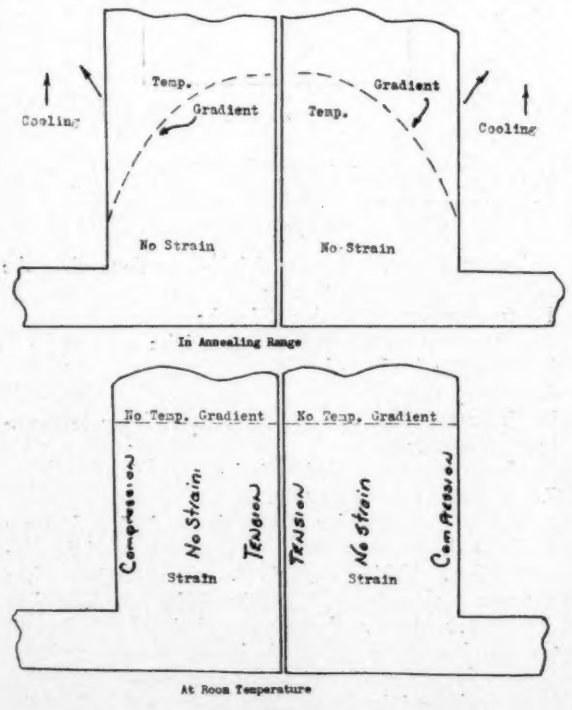


Fig. 1

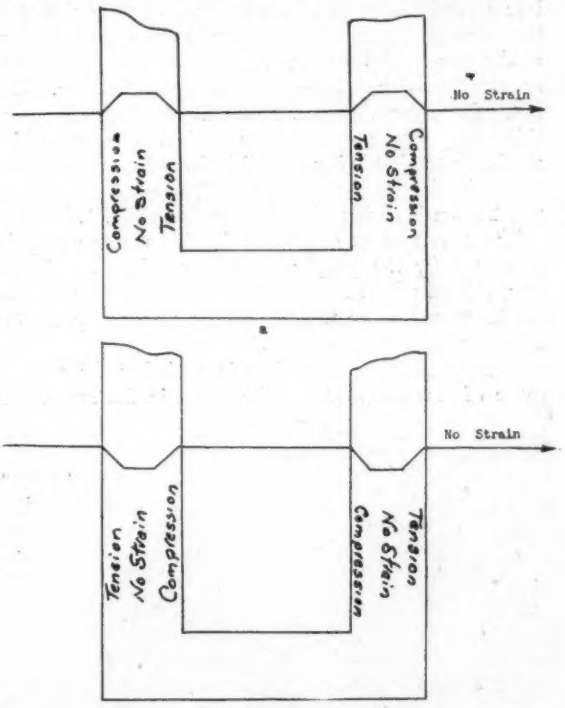


Fig. 2

A practical example of the above may be found in the case of a shipment of bottles received by a large catsup concern. During the filling of the bottles (hot fill) all of the bottles fractured immediately after they received the first few ounces of hot catsup. This amount of breakage had never before been experienced on past lots of the same type of bottle. A check on the temperature of the catsup showed that it actually was at the minimum figure. Examination of the bottles showed the existence of an appreciable amount of tension on the surface of the base and on part of the connecting sides. The temporary tension developed by the thermal shock combined with the permanent tension already present was sufficient to cause the breakage. A lower filling temperature would have eliminated the breakage but as it was impractical to do so the entire lot of containers were condemned to the cullet pile.

In practice, tension is not placed on the outer surface of a glass article intentionally but gets there through accident, either through faulty annealing, glass inhomogeneity or in the case of flashed or welded glass through imperfect matching of the two glasses. Its presence through faulty annealing is rare and usually is caused (especially in the case of containers) by carelessness. For example, wide mouth flat-sided bottles placed in the leer so that the sides of the bottles are nearly in contact can create permanent tension in the outside surface of the ware. The surfaces in close contact cannot cool as readily as the inside surfaces of the bottles. The latter thereby cools quicker than the corresponding outside surface and a temperature gradient is set up which results in tension being established on the outer surface when the bottle becomes cool. The establishment of this tension is sbown diagramatically in Fig. 1.

The development of tension in this manner may be prevented by the proper stacking of the ware in the leer, allowing sufficient space between the rows so that the inner and outer surfaces of the bottle may cool at approximately the same rate.

Inhomogeneity of the glass is probably the greatest cause of permanent tensional stresses in the article. A cord may be defined as a streak or layer of glass differing in composition from the main body of glass. The cord therefore must differ from the main body of glass in physical properties such as density, coefficient of expansion, heat conductivity and the like. Being different in expansivity the cord, when the glass becomes cool, will exist in a state of strain either compressive or tensional. If the cord consists of glass lower in expansivity than the main body of glass it will during the cooling operation tend to occupy a smaller volume compared with the main body of glass. This action is partly prevented by the main body of glass and the cord when the glass is cool because under tension. The reverse action takes place when the cord is higher in expansivity.

Cords that either run close to the outer surface of the glass or comprise this surface in whole or in part will therefore throw this region into a state of permanent compression or tension. Unfortunately, the cords found in practice are usually of such a composition that tension is nearly always formed and the development of compression is seldom encountered.

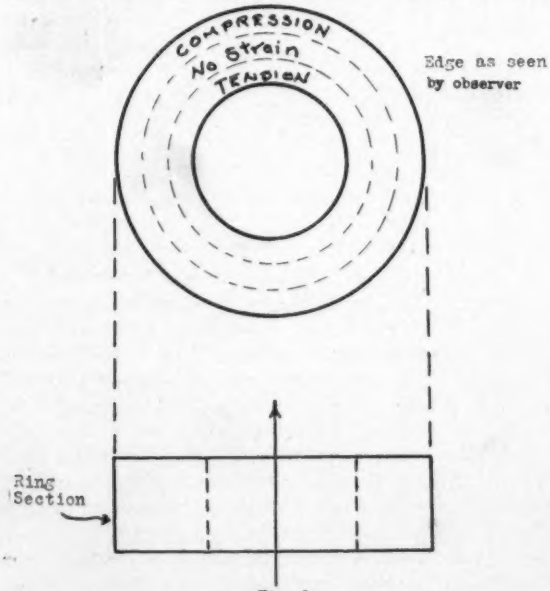


Fig. 3

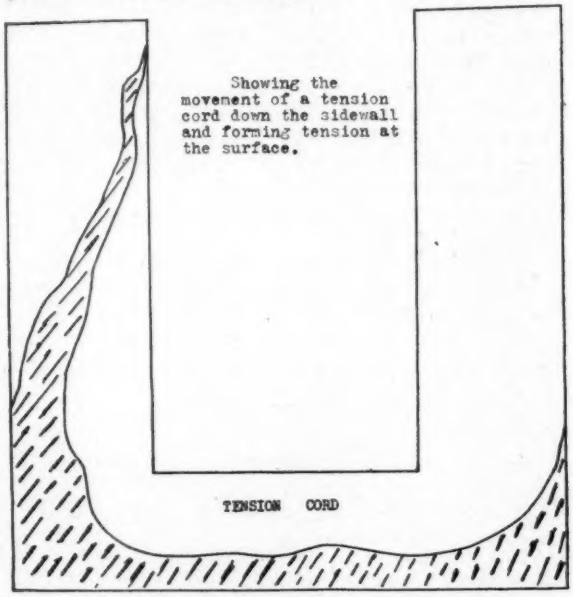


Fig. 4

Among the many causes of inhomogenious glass the following may be mentioned:

1. Improperly proportioned batch;
2. Improper grain size batch materials;
3. Poorly mixed batch;
4. Segregation;
5. Improper melting temperature and large temperature variations;
6. Large tonnage pulled variations;
7. Scum and devitrification.

Of these seven major causes, items 4, 5 and 6 are probably the worse offenders in the creation of the tension defect. Taking each in turn, segregation, when it forms a glass lower in density and expansivity than the regular glass, will cause the delivery of glass to the forming machines that is in the proper condition for the formation of tension-forming cords. Likewise, large variations in the daily pull of glass and in the

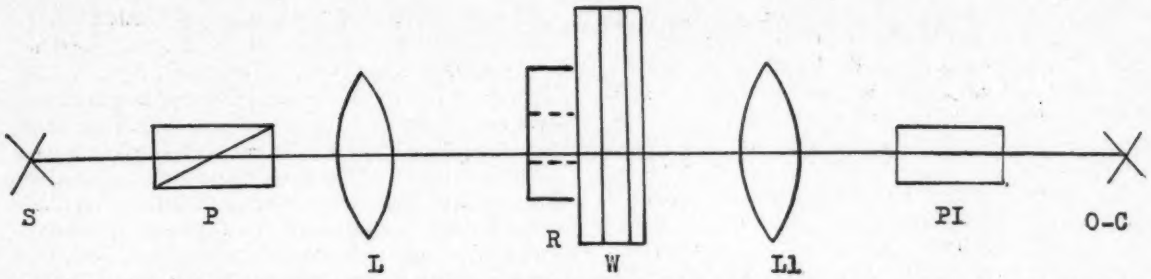


Fig. 5. Schematic drawing of optical set-up: S, light source; P and Pl, polarizing and analyzer nicols, crossed; L, collimating lens; Ll, field lens; R, ring section, W, quartz wedges of compensator; O-C, observer or camera.

temperature of the furnace and its various parts such as are caused by the removal of cooling air, hot spots or faulty burners, will cause the tension type of cord by changing the normal flow lines in the furnace with the result that the stagnant areas of glass will move and join the main lines of flow causing cordy glass. Stagnant areas in the furnace are usually in contact with the refractory and will pick up considerable amounts of alumina and silica forming glasses of lower coefficients of expansion.

Improper tank temperatures will cause this type of cord either by being too high or too low. In the case of low tank temperatures a portion of the sand in the batch may be unmelted and as it is lighter in gravity than the glass it will float and collect as scum in the stagnant areas of the furnace. The slow solution of this scum will form a glass higher in silica content than the normal glass. With excessive tank temperatures the same type of scum can be formed through the increased and accelerated dripping of the silica crown and side walls.

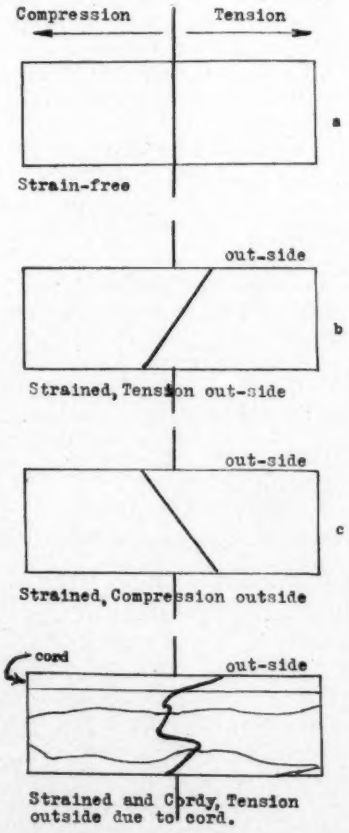


Fig. 6

It is obvious that the tension defects which are produced through inhomogeneity can be prevented by eliminating the various causes of inhomogeneity. However, while the production of cord-free glass is the goal of every glass manufacturer and every means available is used to reach this goal, the causes of inhomogeneity are so numerous and in many cases so very difficult to control, that it is rare to find a plant that has never suffered from this defect.

The development of permanent tension in flashed or welded glasses is similar to that caused by cords as the casing or welding of a layer of glass lower in expansion to the main body of glass results in the development of an outside band of tension exactly like that caused by cords. The remedy, of course, is the selection and use of a casing glass that has the same coefficient of expansion as the glass that is to be cased.

The detection of the tension defect calls for a procedure that is slightly different from the usual polariscopic test for strain. When the polariscope is used in the ordinary manner and a bottle (for example) is examined through its sides the strain observed is the resultant of all the forces present in the two sides. Assuming for simplicity that the glass walls are banded into three zones, one of compression, one of no strain and one of tension: the bottle will appear the same to the observer viewing it through the two sides regardless of whether the first zone is compression or tension and the third zone tension or compression. This is shown in Fig. 2, a and b.

If however a ring section is cut from the bottle and its top or bottom edge examined in the polariscope a different picture is obtained (Fig. 3). By rotating the ring section the type of strain existing around the entire circumference of the bottle may be observed.

While it is possible to make ring section strain determinations with the polariscope it is much more convenient to use a low-powered polarizing microscope as the type of strain, its position, its intensity and its cause (thermal or inhomogeneity) may all be determined at the same time.

In the microscopic method the ring section is placed on the stage of the microscope (the surface under examination may be ground and polished or else ground only. In the latter case the ring section is immersed in a liquid having the same refractive index as the glass) and the microscope focused on the top surface of the

section. With the nicols in the crossed position and a "red of the first order" tint plate inserted in the tube, a strain-free section will appear red, i.e., the same color as the field, and will remain so when the stage is rotated. In the case of a strained section the strained areas will appear alternately red and blue and orange as the stage is rotated.

The type of strain is determined when the section is in the position that shows the maximum blue and orange color intensity. Tension appears as blue or orange and compression as orange or blue depending upon the angle in which the section is placed. A standard angle, for example, north to south, should always be used and the color of tension and compression determined for this direction by mechanically stressing a strain-free piece of glass and examining it while strained.

In some cases it is necessary to cut either vertical sections or several rings sections from various parts of an article as the cord may originate in the center of the glass and work its way outward forming a tension cord at the surface some distance away from its point of origin (Fig. 4).

The polarizing microscope method works quite well with colorless or light-colored glasses. In the case of glasses colored in such a manner that the blue and orange strain colors produced by the tint plate are masked, a more complicated set-up is required. If instead of a tint plate a Babinet compensator is inserted in the microscope tube, colors are no longer developed but a black line appears in the center of the field, and on either side of it a series of colored bars when white light is used or black bars separated by white spaces when monochromatic light is used. When strain free glass is placed in the field the black bars remain in their original position. With strained glass the lines are displaced and the amount of displacement is proportional to the stress. A displacement in one direction indicates tension, and in the other direction it indicates compression. As a microscope equipped with a Babinet compensator is too bulky for convenient use a system such as is shown in Fig. 5 is usually used. Fig. 6, a, b, c and d, shows the appearance of the field when strain free; thermally strained and cord strained sections are placed in the field. For simplicity only the center band has been drawn.

As the tension defect may often have serious consequences the adoption of a checking procedure through which the product is periodically examined for the defect by some suitable method will materially assist in preventing complaints by detecting the unsafe or off-standard ware before it leaves the plant. If such a procedure is standardized and adopted as part of the routine control, it will in many cases detect developments that are leading to the formation of the tension defect many hours before they actually become serious. Production can then be stopped, the proper diagnosis of the trouble made and the necessary steps to clear it taken long before it would be if such a procedure were not followed.

BISSELL TO MIXING EQUIPMENT CO.

E. S. Bissell, who since 1929 has been technical adviser on industrial equipment in the Instrument Division of the Bausch & Lomb Optical Co., has joined the Mixing Equipment Co., Rochester, N. Y., as sales manager. His duties will include advertising and sales promotion.

HAVANA TRIP AFTER A. C. S. MEETING

Following the annual meeting of the American Ceramic Society at the Waldorf-Astoria, New York, March 21-27, a special cruise to Nassau and Havana has been arranged for the Easter holidays, leaving New York upon termination of the meeting, March 27. Two and a half days will be spent in Havana, using the ship as a hotel without extra cost. From there to Nassau, and then home, arriving in New York the afternoon of Sunday, April 4. The fare is $95. and up per person, including stateroom, meals and shipboard entertainment. Further details may be obtained from H. H. Allen, Thos. Cook & Son—Wagons-Lit, Inc., 587 Fifth Ave., New York.

OPTICAL SOCIETY MEETS MARCH 5-6

The spring meeting of the Optical Society of America will be held at Corning, N. Y., March 5 and 6. Additional sessions may possibly be scheduled for Thurs., March 4, if warranted by the number of contributed papers. A special feature of the meeting will be the opportunity offered through the courtesy of the Corning Glass Works to see at first hand many applications of optics in the glass industry and contributions of the glass industry to optics. The meeting will be open to non-members as well as to members.

OPTICAL GOODS PRODUCTION IS UP

A substantial increase in employment and production in 1935 has been reported by manufacturers of optical goods for the Biennial Census of Manufacturers taken in 1936 by the Bureau of the Census Department of Commerce. The total value of the production in 1935 was $33,600,389 or 28.2 per cent more than the value in 1933, the preceding Census year. The number of wage earners had increased from 7,598 reported in 1933 to 9,667 in 1935 with an increase in wages of 41.5 per cent. Chief products reported were: spectacle and eyeglass frames, mountings and parts valued at $11,610,994; ophthalmic lenses, $9,405,684; optical instruments and parts, $4,335,607.

Harold Van Doren has been appointed color consultant to The Libbey-Owens-Ford Glass Co. His activities will be directed towards the solution of color problems associated with structural glass. Mr. Van Doren has had a wide experience in the color field, as well as being one of the country's foremost industrial designers. He directed the color research and standardization of a leading urea resin recently carried out at The Mellon Institute, Pittsburgh, Pa.

PITTSBURGH SECTION OF A.C.S.

At the January meeting of the Pittsburgh section of the American Ceramic Society, the following officers for 1937 were elected: chairman, E. C. Petrie; vice chairman, D. G. Bennett; secretary, W. C. Rueckel; treasurer, D. D. Hepplewhite. An interesting talk on super-refractories, illustrated by a two reel picture was given by Dr. A. P. Thompson, Carborundum Co. fellow at the Mellon Institute. One reel in color showed the physical structure of a number of refractory materials as viewed with the petrographic microscope. The other reel portrayed the rates of solution of various refractories in basic and acidic glasses as viewed with a thermal microscope.

THE BRITISH GLASS INDUSTRY

By WARREN S. LOCKWOOD*

It has been authoritatively stated that glass making was carried on in England as early as the time of the Roman occupation (A.D. 43). Since that time the history of this industry contains gaps but in 669 the use of glass windows in a church was reported and again mention was made in 1439. It was in 1549, however, that an industry was actually set up, aided by eight Italian glass-makers who came to England attracted by the offers of Edward VI. The industry was further stimulated in the reign of Elizabeth under her system of monopolies and patents for new industries. Next came the discovery of "lead glass" manufacture in 1635 which brought name and fame to the English producers. Since then the manufacture of glass has progressed steadily so that today it is one of Britain's foremost industries.

At the present time the principal concentrations of glass factories are in four main areas (approximate dates of origin are included): in and around London (B.C.); Yorkshire (1650); in and around Birmingham (1785); Lancashire (1696). Also of considerable note as glass centers, but of secondary importance compared with these areas, are the regions around Newcastle-upon-Tyne (1577) and the Stourbridge area, including South Staffordshire and Shropshire (1696).

Production and Employment

The latest available production statistics for the British glass industry are those for 1934 which relate to firms in the United Kingdom employing more than 10 persons as an annual average. The total value of the 24 principal classifications therein listed was £15,505,000 which compared favorably with £13,514,000 reported in 1933. Sheet glass and glass containers are the leading items of production.

Output of Principal Products

Kind of Goods	1934 Value £
Beer bottles	892,000
Other similar bottles	898,000
Chemical, medical & perfume bottles	1,336,000
Milk bottles	622,000
Other bottles and jars	1,989,000
Total—Illuminating glassware	675,000
Table & ornamental (including toilet)	926,000
Plate & sheet glass & bevelled decorated and silvered glass	4,866,000
Mirrors, framed or unframed	585,000
Safety glass for motor cars, etc.	989,000

The average number of persons employed in the British glass industry during 1934 was 43,525—a sizeable increase over the 1933 figure of 39,791. Net output per person employed increased from £212 to £228.

Average Employment

	Males		Females		Total	
Persons Employed	Under 18	All Ages	Under 18	All Ages	Under 18	All Ages
Operatives (average for the year):—						
1934	3,600	31,963	1,982	6,609	5,582	38,572
1933	2,967	29,030	1,842	6,025	4,809	35,055
Administrative, technical and clerical staff*:—						
1934	319	3,435	208	1,518	527	4,953
1933	207	3,360	189	1,376	396	4,736
Total 1934	3,919	35,398	2,190	8,127	6,109	43,525
Total 1933	3,174	32,390	2,031	7,401	5,205	39,791

* As at 13th, October, 1934, and 14th October, 1933.

Raw Materials

British glass manufacturers depend to a great extent on sand imported from Belgium and France and to a small extent, Germany. For certain types of ware, local sources of sand are used, supplied chiefly by pits at Kings Lynn. This sand is reported to be of fair quality but for the best types of glassware the imported material is employed.

Materials Purchased and Used 1934

Kind of Materials	Quantity Tons	Cost £
White sand	362,000	246,000
Other sand	181,000	64,000
Limestone	99,000	72,000
Carbonate of potash	600	16,000
Soda ash	139,000	746,000
Oxide of lead	1,200	27,000
All other materials used (including fuel)		5,070,000
Total		6,241,000

Imports

The latest official detailed import statistics, sub-divided by countries of origin and class of glass products imported into Great Britain are available only through the year 1934. Total figures are available, however, for four principal import groups through the full year 1935 and the first 10 months of 1936. The total volume and value of British imports of "illuminating glassware," "domestic and fancy glassware," "plate and sheet glass other than spectacle glass" and "glass bottles and jars —other than scientific glassware" are summarized below for 1934 and 1935 and for the first 10 months of 1936:

British Imports of Glass—1934, 1935, *Jan.-Oct.* 1936

Products	1934 Volume cwts.	1934 Value £ sterling	1935 Volume cwts.	1935 Value £ sterling	Jan.-Oct. 1936 Volume cwts.	Jan.-Oct. 1936 Value £ sterling
Illuminating glassware	98,151	375,473	92,931	421,032	83,069	385,160
Domestic & fancy glassware	382,372	1,077,790	393,296	1,117,758	287,149	823,397
Plate & sheet glass, other than spectacle glass	1,627,873	1,410,301	1,724,783	1,561,304	1,552,447	1,350,236
Glass bottles & jars & tubular containers, not elsewhere specified other than scientific glassware	gross 507,396	266,902	gross 710,512	335,314	gross 563,822	255,139

* Assistant Trade Commissioner, London. Released through courtesy of Specialties Division, Bureau of Foreign and Domestic Commerce.

The detailed official import statistics available through the year 1934 are divided into 34 different categories of glass and glassware, for which the volume of trade is sufficient in 20 items to include subdivision of total imports under the item by countries of origin.

It is significant that of these 20 items, Germany was listed as a supplier for 19, Czechoslovakia for 16 and Belgium for 14. The United States appears as a separately listed supplier in only 5 items.

These figures are given only as an indication of leading suppliers. It is important to note that changes in classifications affect some of these items, and countries of origin appear several times under two headings when the item is really a single item but shown twice due to minor changes in classification for the most part occurring between 1932 and 1933.

The items for which the United States was listed as a supplier, together with 1934 imports from the United States, and total imports, are listed below:

British Glass Imports from United States—1934

Commodity	Imports from U. S. A. £ sterling	Total imports £ sterling
Chemical, medical, surgical, bacteriological (including glass syringes)	1,433	65,669
Globes and shades (other than oil lamp chimneys)	932	237,272
Domestic and fancy glassware (including cooking utensils, table glassware, ornamental glassware)	5,454*	702,241*
Glass bottles and jars (other than scientific glassware) not beer, wine, spirit & similar bottles or milk bottles	5,596	215,928
Glass and glassware, not elsewhere specified	5,155	185,382

* Note: Figures given here are for 1932. 1934 figures not available owing to change in classification.

The following is a brief summary of imports under the principal groupings for the year 1934 (by "principal groupings," for the purpose of the following summary, is meant all items the total import value of which in 1934 exceeded £50,000):

Chemical, Medical, Surgical, Bacteriological (including Glass Syringes)—Germany is by far the leading supplier in this category furnishing £55,431 of the total imports, as indicated above, of £65,669.

Illuminating Glassware—Electric Lamp Bulbs, incomplete—Netherlands and Belgium are the principal suppliers under this heading, together accounting for £58,404 of total imports of £76,535. Until 1932, Netherlands was the dominant supplier but Belgium gained rapidly between 1932 and 1934, and in the latter year slightly led the Netherlands.

Globes and Shades (other than Oil Lamp Chimneys)—Here again Germany is the dominant supplier, accounting for £153,092 of the total of £237,272 Czechoslovakia with £65,393 is the one other large supplier.

Domestic and Fancy Glassware (Table, Toilet and Ornamental)—Germany, Belgium and Czechoslovakia dominated this trade, the combined imports from these three suppliers alone totalling £902,325 of the total figure of £1,073,334. The three principal suppliers shared almost equally in this trade, although Belgium's total was slightly less than the other two. Sweden next, accounted for only 18 per cent of Belgium's figure.

Plate and Sheet Glass (Plain Sheet Window Glass)—Belgium is by far the principal supplier of the plate and sheet items, accounting for more than half of the total of £635,907 under the above heading. Czechoslovakia was the second largest supplier, with slightly more than one-third of Belgium's total, followed by Germany with about one-fifth of Belgium's total.

Plate and Sheet Glass (Plate Glass, polished, not further worked)—Here again Belgium is the dominant supplier, accounting for £402,188 of the total of £546,591. Germany is the second largest supplier with little more than one-fifth of Belgium's total.

Plate and Sheet Glass (Plate Glass, polished and silvered, bevelled or otherwise worked)—Belgium supplied £52,683 of the total imports of £55,133.

Plate and Sheet Glass (other descriptions)—Belgium furnished £133,383 of total imports of £172,670.

Glass Bottles and Jars (other than scientific glassware) beer, wine, spirit and similar bottles—In this item Sweden, with £20,952 of a total of £50,970, was the principal supplier, followed by Germany, Netherlands and Belgium in the order named.

Glass Bottles and Jars (not Milk Bottles, and other than scientific glassware)—Germany contributed more than half the total of £215,928, followed by Czechoslovakia with less than one-third of the German total.

Glass and Glassware, not elsewhere specified—Here again Germany is the principal supplier, accounting for £82,120 of the total of £185,382, followed by Belgium and Czechoslovakia which combined shipped less than the German total.

Exports

The latest official detailed export statistics, sub-divided by countries of origin and classes of glass products exported, are also available only through the year 1934. Total figures are available, however, for six principal export groups through the full year 1933 and the first ten months of 1936. The total volume and value of British exports of "illuminating glassware," "domestic and fancy glassware," "plate and sheet glass other than spectacle glass," "scientific glassware and glass tubing and rod," "glass bottles and jars and tubular containers, not elsewhere specified, other than scientific glassware," and "all other kinds of glass and glassware, not elsewhere specified" are summarized below for the years 1934 and 1935, and for the first ten months of 1936:

British Glass Exports—1934, 1935, *Jan.-Oct.* 1936

	1934		1935		Jan.-Oct. 1936	
Products	Volume cwts.	Value £	Volume cwts.	Value £	Volume cwts.	Value £
Illuminated glassware	4,167	44,655	4,675	47,955	3,719	40,396
Domestic and fancy glassware	31,548	206,547	34,869	227,820	37,407	217,612
Plate and sheet glass, other than spectacle glass	516,097	797,170	571,248	798,598	441,798	640,434
Scientific glassware and glass tubing and rod	....	93,899	....	96,458	....	82,194
Glass bottles & jars & tubular containers n.e.s. other than scientific glassware	gross		gross		gross	
All other kinds of glass & glassware, n.e.s.	281,276	223,558	307,120	236,754	248,833	200,747
	cwts.		cwts.		cwts.	
	11,872	69,907	17,780	107,549	....	110,771

COMPARATIVE STATISTICS OF THE BRITISH GLASS TRADE

Production. Exports and Imports

Kind of Goods			Production	Exports	Retained Imports
Glass bottles & jars:—					
Beer, wine, spirit & similar bottles	Th. gross	1934	2,686	62	87
		1933	2,430	54	92
	Th. cwts.	1934	3,378	86	124
		1933	2,932	70	132
Milk bottles	Th. gross	1934	657	12	*
		1933	553	10	*
	Th. cwts.	1934	841	15	*
		1933	749	13	*
Other bottles & jars	Th. gross	1934	7,132	208	413
		1933	6,563	255	398
	Th. cwts.	1934	4,355	134	105
		1933	4,125	176	113
Total—Glass Bottles and Jars	Th. gross	1934	10,475	282	500
		1933	9,546	319	490
	Th. cwts.	1934	8,574	235	229
		1933	7,806	259	245
Domestic & fancy glassware:—					
Table, toilet & ornamental	Th. cwts.	1934	342**	26	379
		1933	324	18	376
Other (including cooking utensils)	Th. cwts.	1934	37	6	1
		1933	46	9	2
Total—Domestic & fancy glassware	.....	1934	379**	32	380
		1933	370	27	378
Illuminating glassware:—					
Bulbs for electric lamps	Mill	1934	74.1	0.1	22.0
		1933	64.6		15.2
	Th. cwts.	1934	50.3	0.1	15.2
		1933	40.0	*	10.8
Globes & shades (other than oil lamp chimneys)	Thous.	1934	5,694**	156	8,572
		1933	3,235**	161	9,935
			Value (at factory) £	Value (f.o.b.) £'000	Value (c.i.f.) £'000
Total—Illuminating glassware of all descriptions		1934	675	45	371
		1933	584	40	337
Scientific glassware (except tubing and rod)		1934	200	74	66
		1933	154	56	47
Glass tubing & rod, for all purposes		1934	211	20	34
		1933	174	21	35

* Negligible. ** Including estimates for output returned by value only. Less than 50,000.

The following table shows the total value of British glass and glassware exports during the years 1933 and 1934 to all markets taking in the year 1934 more than £40,000, together with the grand totals of exports of British glass and glassware to Empire countries and to non-Empire countries:

British Exports of Glass to Principal Markets 1933-1934

Country of Destination	1933 £	1934 £
Union of South Africa & S. W. Africa Territory	150,236	236,585
Australia	124,906	173,079
Canada	120,306	168,618
Irish Free State	174,465	137,448
British India	97,561	92,062
New Zealand	55,807	83,981
Other British Countries	117,566	129,339
Total to British Countries	840,847	1,021,112
Argentine Republic	86,286	80,317
Denmark	31,998	49,216
Japan (including Formosa)	57,845	48,744
United States of America	31,253	40,480
Other Foreign Countries	215,235	195,867
Total to Foreign Countries	422,617	414,624
GRAND TOTAL	1,263,464	1,435,736

United States purchases of British glass and glass products are most important in the following lines: "plate and sheet glass," "domestic and fancy glassware, table, toilet and ornamental glass" and "glass tubing and rods for all purposes."

DEATH OF W. J. LATCHFORD

It is with deep regret that The GLASS INDUSTRY reports the death of W. J. Latchford, president of the Latchford Glass Co., Los Angeles, on January 13th at the age of 74. Born in Ireland, he first settled in Chicago, moving to Los Angeles in 1910 and founding the Southern Glass Co. in 1917. This plant, said to be the first successful bottle plant in Southern California, was purchased by the Illinois Pacific Coast Co., which was later taken over by the Owens-Illinois Glass Co. In 1925, Mr. Latchford and his step-son, Baird Marble, sold out their interest in the Southern Glass Co., and that same year Mr. Latchford founded the Latchford Glass Co. A pioneer and prominent figure in this history of glass making on the Pacific Coast, Mr. Latchford's death is a great loss to the industry.

The November, 1936, issue of *Sands, Clays and Minerals*, published at Chatteris, Cambs, England has just been received. Among articles of possible interest to glass men are the following: "The Application of Titanium Oxide in Industry," "Boron, the Metal and Its Uses."

1

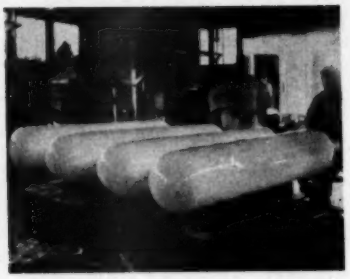
2

3

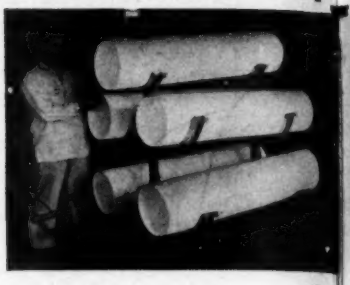
4

5

6



7



8

1, the gathering operation. 2, the first gather, blocked and puffed, ready for covering. The "cowboard" around the nearer workman's neck has a mouth piece to be held between the teeth and a pane of colored glass to protect the eyes, while the board shields the face from the heat. 3, the first gather is being blocked in a cast iron bowl lined with charred sawdust. The puffing necessary to form the neck of the gather and start the blowing operation is being done with the help of a compressed air nozzle. 4, the gather now begins to increase in size and the neck has been finished and is being cooled by wind. 5, the ball has now been blown further and swung in the pit until it has been stretched into the cylinder which the workman is reheating in the glory hole preparatory to further extension. 6, the cylinder has now been completed and will be carried to the rack shown in 7, where the pipe is removed by touching the neck with a cold iron to start a small crack. Here also threads of molten glass will be wrapped around the cylinders near the ends, causing them to crack off squarely. 8, the cylinders now have both ends removed, and have been scored lengthwise with a diamond. A hot iron has been passed back and forth until the cylinder has split. Each cylinder will now be warmed separately in a flattening oven to about 1400°F. and opened out, first by iron tools and then by smoothing with charred wood into a flat sheet.

9 and 10 show the blocking of the gather and its preparations for blowing. 11, the workman is reheating the gather for the last time to get it well softened and the heat well distributed, ready for the final blowing. 12 and 13, the completion of the blowing. Again an air hose has been called upon to supplement the workman's lung-power. 14 and 15 show finished balls set out to cool, ready for the initial cutting-up operation. 16, a loop of wire electrically heated is wrapped around a ball which will presently crack in half as shown in 17. The high fire polish of these balls is indicated by the reflection of the windows and skylights of the factory as high lights in the illustration. 18, a movable rack loaded with segments of goggle balls ready for the cutters. 19, a mechanical device for producing the circular or elliptical scorings which will release the proper shaped panes.

Production of white opal flat glass from mouth blown cylinders

Production of goggle balls to be cut up into panes for goggles

9

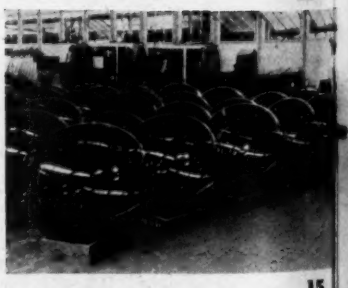
10

11

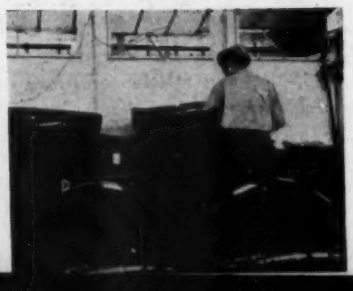
12

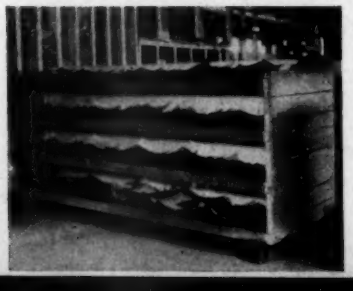
13

14



15





Leon J. Houze, Sr.

CONVEX GLASS

The History of the L. J. Houze Convex Glass Company

In the little town of Point Marion, Pennsylvania, where the Cheat River flows into the Monongahela, is located one of the most interesting of glass factories. Leon J. Houze, glass blower, inventor, builder, and organizer came from Belgium in 1879 to blow window-glass cylinders for an Ohio factory. He soon became a boss blower, and within a few years began the building and operating of window glass plants. His acquaintance with methods in use in Belgium, a country whose leadership in the flat glass field was at that time undisputed, coupled with his own inventive genius, made him in great demand as builder of tanks and designer of equipment for American window-glass factories.

It will be news to many that he was probably the first man to demonstrate that natural gas is eminently suitable for a glass-melting fuel. This was in 1881, when he was invited to come to Olean, N. Y., where he constructed a simple brick tank, and actually melted glass in it from raw materials, using the new fuel, and earning a fee of five hundred dollars. Nowadays, when natural gas is used in so many factories that it might be called the standard glass-house fuel of America, it is difficult to realize that it is scarcely more than a half century, and within the active lifetime of this one man who is still an important figure in the industry, since natural gas was first applied for this purpose.

Another "first" to be credited to Mr. Houze is the now familiar construction of glass tanks in which the jamb walls are carried on brackets on the buck-stays; and thus, together with the crown, they are supported independently of the blocks, making it possible to remove worn-out blocks for repairs without disturbing the superstructure. A half-dozen other inventions are covered by patents issued to this energetic man, although the invention of the buck-stay bracket was a free gift to the American furnace builders. Among his inventions are devices for holding glass disks on cast iron formers in a heating oven, and softening them into convex shapes. These pieces find a multitude of applications as covers for pictures, for clock faces, instrument dials, and the like. When the blowing of window-glass cylinders by mouth became superseded by processes for drawing flat glass into sheets mechanically, Mr. Houze turned to this production of convex glass as a specialty, and converted his window-glass plant into the L. J. Houze Convex Glass Company.

During the war, when the importation of colored glass for goggles for eye protection became impossible, American importers and manufacturers of goggles turned to him for help. Beginning with amber, and afterward developing green, blue, fieuzal, smoke and numerous special tints for sun glasses and for welding goggles, the company have made themselves leaders in this field of manufacture.

One of the few places in the country—if not the only one—where the blowing of window-glass cylinders by mouth can still be observed, is in this factory. Manifestly, it is not feasible to set up machines for drawing special colors, no one of which can be produced in great quantities, and each one requiring careful compounding and special control of the melting process. Cylinder blowing, cutting and flattening, and annealing in the old way, produce a quantity of flat glass, crystal, opal, cased, and solid color, which is used for a variety of purposes. For signs, for ornaments, and for special forms of lighting fixtures, as well as for goggles with flat panes, blown sheets are indispensable.

Curved or convex goggle lenses are made by blowing the glass into large globes or "goggle balls", more than 24 inches in diameter. These are cut apart into segments by means of hot wires, then scored with diamonds carried by special machines, and cut apart into circles, ellipses, and other special curved shapes to fit spectacle frames. Needless to say, these "goggle balls" are among the largest pieces of mouth-blown glassware ever produced.

For the production of the special colored glasses for these different purposes, individual pot furnaces have been developed. These furnaces are constructed to hold one pot each, in order that the atmosphere of the furnace may be controlled for the peculiar requirements of the color which is being melted; also, the melting cycle and the cooling to the precise temperature required for making these huge gathers can thus be taken care of very carefully for each separate melt, without the compromises which would become necessary, where several pots present in the same furnace.

Open pots of large diameter and relatively shallow depth are used. The charge is put in in three or four additions in order to fill the pot without loss by foaming. Very large gathering rings are used, floating on the glass, and the ringhole or gathering orifice in the furnace wall must likewise be of large diameter in order to accommodate the heavy gathers to be brought out. It has been found possible to connect several of these individual furnaces to a single stack, and separate dampers are used to control the draft for each furnace. A degree of recuperation is obtained by bringing the air for combustion beneath the bottom of the furnace before it meets the in-coming natural gas at the back of the furnace. The fire is carried over a bag wall, whence it passes over and around the pot and down through the outlet flues near the front and bottom of the furnace. Gas consumption is necessarily high, but the precision of control and the convenience of operation compensate for the greater melting cost.

In addition to these items of convex glass, flat glass for many purposes, and goggle lenses, a number of other specialties have been developed in this factory.

Many items are blown in paste molds, and many articles such as ash trays and lamp bases are gathered and pressed by hand. Becaue of their skill in making colored glasses, and because of the presence of many highly trained workmen, these people are in position to take care of a multitude of special pieces which could not be undertaken by larger plants, whose routine of production is less flexible, and whose melting processes are such that standardization of ware and its manufacture in large quantities are necessary for economical operation. Because of the peculiar nature of their plant and its equipment, their aim cannot be tonnage, but they are in position to produce the small and the unusual, in whatever shape and color may be required.

The most recent development in this factory is the installation of a small continuous tank of about six tons' daily capacity, with a recuperator and a system of diffusion combustion. To this tank has been connected a small Fourcault machine capable of drawing heavy sheets up to thirty inches in width, from which it is planned to cut blanks for spectacle lenses. There will thus be present in the same factory, the unusual combination of the oldest extant methods of making flat glass, almost under the same roof with one of the most modern processes. Needless to say, the careful treatment both of raw materials and of melting and working processes necessary to the production of high grade spectacle glass by this method will require just such painstaking treatment as the Houze organization by their long and varied experience, are equipped to apply.

Leon J. Houze, a truly great figure in the American glass industry, thus represents a connecting link between the very old and the very new in flat glass, and his lifetime covers a tremendous amount of change, development, and improvement, "all of which he saw, and a part of which he was." His sons are carrying on the tradition: Roger J. is the managing head of the organization; Armand L., Sr. handles the important matters of glassmaking and furnace-and-factory operations; another son, Leon, Jr., gives his attention to the office work; and three sons-in-law, the two Board brothers and Mr. Jack Foltz, are also members of the corporation and active in its management and operation. A grandson, Armand L., Jr., is a recent graduate in glass technology from the New York State College of Ceramics at Alfred.

SELECTION OF COLORS FOR SIGNAL LIGHTS

At the request and with the financial support of the Bureau of Aeronautics, Navy Department, an investigation was undertaken by H. J. McNicholas at the Bureau of Standards to determine the best color limits for signal lights constituting a six-color system. The choice of suitable colors for any signal system is determined primarily by the number of colors required and the service conditions. In the present application the lights must be readily identified over a distance of approximately 1,500 feet, under weather conditions varying from a clear atmosphere to light haze. The signals are seen and identified as point sources of low intensity, and the colors are limited to those obtainable by combinations of an incandescent lamp and colored-glass cover globes.

Under these service conditions the problem is reduced to a choice between two six-color systems. One system consists of red, orange-yellow, white, green, blue, and purple. The other system consists of red, orange, yellow, white, green, and blue.

The best ranges of each color were determined and comparison made between the two systems. The work was done on an outdoor test range by groups of normal observers, under test conditions closely simulating those required in service. Various test colors were exhibited at different intensities in random order, and observers were asked to assign each color to one of the 6 permitted color classifications. In this way approximately 58,000 single observations were recorded in the selection of the colors and their tolerance limits.

As described in the December number of the *Journal of Research* (*RP*-956), it was found that the orange and yellow were the least distinctive as signal colors when both are used with red and white. Permissible tolerances were also found to be too restricted for easy reproduction of the colored glassware. Furthermore, these orange and yellow colors are not stable with varying distance and appear shifted toward the red as the distance is decreased (higher signal intensity).

Considerable difficulty was experienced in the discrimination between green and blue and it was found that a highly saturated "sextant" green was required to gain the maximum distinctiveness from a saturated blue. At long distances (low signal intensities) a tendency to confuse the green and blue is unavoidable.

Purple, in general, is not a good long-distance signal color because of the low transmission of light by all purple-glass cover globes and the well-known dichromatic nature of this signal when seen as a very small source. This color proved to be very distinctive, however, when the signal intensity was made comparable with that of the other colors. This required a lamp intensity at least 21 times that required for white or yellow signals.

On the whole, the tests favor the selection of red, orange-yellow, white, green, blue, and purple as the best six-color signal system for the required service conditions.—*Technical News Bulletin of the National Bureau of Standards, December*, 1936.

MOREY LECTURES AT ALFRED

G. W. Morey, physical chemist, of the Geophysical Laboratory of Washington, noted for his investigations on the devitrification of glasses and on the processes of crystal formation in silicate melts, addressed the student branch of The American Ceramic Society at the New York State College of Ceramics, Alfred, on Jan. 19. Dr. Morey spoke on "The Derivation and Interpretation of Phase Rule Diagrams." He exhibited some of the apparatus used, and explained the painstaking procedures necessary in determining the liquidus temperatures of various compositions and in identifying the crystal phases formed when glass compositions devitrify.

Recent developments in glass will be one of the subjects to be covered in a course on "Contemporary Interior Materials and Color" to be given in the extension division of Columbia University during the Spring Session by Theodore Carl Muller, designer. The bases of color theories, and their applications in the light of physics, chemistry, psychology and aesthetics will be presented.

RECENT GERMAN CONTRIBUTIONS TO GLASS TECHNOLOGY AND VOCABULARY

Berger and Geffcken, in *Glastechnische Berichte*, for Dec., 1936, have published a second paper on the question of the size of the surface of glass particles. This is the subject which was covered by Dr. Berger in a paper read before the International Congress last July. The authors discussed the influence of the method of crushing as it affects the shape of the particles. Sieving enters into consideration. This is necessarily a slow procedure, and some suggestions are made for its improvement. Examination of the errors due to sieving leads to the conclusion that when mechanical sieving is employed, the time of shaking should not exceed ten minutes.

The silhouettes of particles of given size are obtained by means of a special photoelectric process. These show a direct relationship to the surface of the particles, which are considered as smooth, and reflect the influence of the method of pulverizing and their dependence upon the mean value of the sieve dimension. The authors summarize the earlier and present-day knowledge of the subject and call attention to certain points in the preparation of powdered glass or glass particles for durability tests:

1. The original glass does not need to have any special shape, but consists essentially of well annealed, thick plates or cullet.

2. Crushing is done in a mortar which is not too small, and whose pestle can be driven by a blow only within two millimeters of the bottom of the mortar.

3. After a single, or at the most, two blows, the crushed glass is brought upon the first sieve and shaken there for one-half minute. The residue is returned back to the mortar where it receives again two blows of the pestle, and the product is again brought upon the first sieve, and so forth, until only a small residue remains.

4. The first sieve must have a definitely greater mesh-size than the coarser of the two principal sieves in order to insure proper distribution of volume.

5. For the principal sifting process, the first sieve is fitted to the coarser of the two principal sieves, and shaken mechanically for two to five minutes with occasional freeing of the sieve from clogging grains.

6. The reliability of the sieve is tested from time to time according to the standard procedure (for example, by estimating grain size, z, in each cm^3 of the glass)

$$\left(z = \frac{1}{F_v} \cdot \frac{2 L_1 L_2^2}{L_1 L_2} \text{ where } F_v = 0.62, \text{ and L is in cm.} \right).$$

7. There follows washing with water-free alcohol, or better, ether, with gentle shaking. Particles that have become stuck together are removed by means of a suction nozzle or tweezers.

In the same number of *Berichte*, R. Schultze reports upon the clarification of technical expressions used in connection with glass manufacture. While this exposition refers specifically to German words, it may be of interest, since it endeavors to clear up some confusion and misunderstanding resulting from the careless use of these terms. It would probably be well if we examined similarly our own words applied to plant processes and to the incidents occurring in the melting and working of glass with a view to getting more exact meanings and a more consistent and accurate use of the words.

In storage, glass tends to become "tarnished" or "dull" if it does not have sufficient durability or power to withstand weathering. The Germans use also the expression "blued" as referring to the faintly colored effect which weathering gives to the surface.

Another defect referred to as "burnt" or "blasted" evidently arises on mouth-blown window-glass because of burning in dirt or dust on the glass surface. A similar defect may arise in ware mechanically produced, if the blowing or cooling wind is dusty or carries oil.

The German expression "Einlauf", literally a "running in," apparently refers to what we call variously checks, fire-cracks, or crizzles, which are tiny cracks leading from the surface or edge toward the inside which may cause a sheet, or plate, or piece of glassware to break very easily.

The German word "entglasen", literally to "unglass" or as we say, devitrify, refers to the formation of visible crystals or to the process of crystal formation in the glass. This phenomenon takes place when the glass is held too long at a favorable temperature for crystallizing; for example, when the last residue in a pot is being worked out or when the glass is being repeatedly heated and worked in a lamp flame. In tanks it sometimes occurs near the ring holes and sometimes when the throat is too strongly cooled. It is a familiar sight when a tank is let out and slowly cooled through a red heat or the crystallizing range and it also takes place in feeders or flowing devices.

Similar adjectives are applied to the glass in this condition as to glass in the tarnished or dull state resulting from weathering. It loses transparency, and may even have a stony appearance.

Words which may be translated as threads or fibers, referring to glass that is thready or fibrous, apparently may also be freely translated as cords or cordy in a more familiar American expression. This very common phenomenon is also described as "striae", and the figurative term "combed" is used in connection with sheet glass in which many of these cords seem to lie together in a sort of bundle. For more exaggerated cords, the Germans use an expression which literally means a ramp or a platform, and corresponds to our term waves. Waves are broader and less definitely bounded than cords. Other words, notably "winden" and "schlieren" refer to cords which are not prominent enough to be felt, but are quite easily visible.

The fine seed or "dusty seed" are terms that have their equivalent in the German for the condition which is expressively although inelegantly called a "lousy seed" by many of our own glass makers. However, a distinction

is made, in the use of the German words, making the terms "fine seed" or "dusty seed" apply to streaks of tiny bubbles in the glass near the surface, also little nests of fine bubbles in the interior of the glass. This is said to be not a fault in the plaining, but in the working. It is thereby differentiated from bubbles or ordinary seeds.

There are also described, fine bubbles in the glass arising from faulty plaining and called "seeds". Likewise, defects that result from something entering the glass from the outside, when it is called "smoky". The difficulty is laid to furnace smoke. The effect is sometimes noticed when oil comes in contact with the hot glass.

Another expression, which is rather strange, is the term "fire white". A somewhat synonymous expression is "festgebrannt" or literally, hard-burned, which seems to indicate that the glass has been overheated in one place and fine bubbles were generated from the glass or, coming from the hot flame, have been fired in and retained as a thin, somewhat opaque, layer under the glass surface.

Somewhat along the line of Dr. Schultze's studies on the application of certain glass-house terms is an unsigned article in *Glashutte*, Jan. 9, 1937, entitled "Some Mistaken Ideas in Technical Expressions."

"Speech is given to mankind in order to express his thoughts", but not only to express them, but also to impart them to his companions and to exchange them. Many uncertainties appear in literature and in history which arises from the changes in the concept which we attach to words, thereby causing our words to conceal our thoughts.

Beginning with the word "melt", and the concept arising from it; we understand by this in the first place, the process by which a substance exposed to a rising temperature passes at a definite temperature point (if it is a crystal) into a fluid condition. Batch, on the contrary, does not "melt" because we know that during the heating process batch undergoes a great number of chemical reactions which in part, as recent investigations have shown, take place in the solid, therefore the unmelted condition, and that it is these newly formed compounds which first began to go into the liquid condition. Most batch raw materials do not begin to melt, with certain exceptions such as borax, salt peter, or salt cake, but begin to form new compounds with the silica, which after further chemical change, become a molten liquid. In the enameling industry, this process is designated as "fritting" as in the preparation of glazes. Formerly, this term found application in the glass industry. We distinguish between frits, that is the process by which the first changes in composition take place, and the true melt which comes later, by which the frit is melted down into the usual glass bath. While it is not necessary to go back to the old expression, frit, nor to apply it to the change by which raw materials go into something more easily molten, as for example, sand and lime becoming calcium silicate, it would still contribute to the clarifying of certain relationships if one would call the process by which glass is formed from batch, "melting down", or better, "melting together", since the destruction of a pot by too high temperature is often described by "melting down".

Using the word "melting" for ordinary fusion purposes, and "melting together" for making glass out of raw materials, would take some confusion out of the word. We would then speak no more of the melting of the batch, for the batch has no melting temperature but only a melting down temperature which is, moreover, no definite temperature point, but a range of temperatures in which the batch must be melted together in order to produce an acceptable glass. This temperature range is, however, less dependent upon the chemical composition of the prepared glass than upon the chemical and physical condition of the raw materials. Thus, if we want to be precise, we must speak of the melting down temperature of the batch rather than that of the glass.

This does not end our difficulties with the word "melt", for we meet it again in another false position, namely, when we speak of the melting of glass. Here we mean the process which a solid glass body undergoes when it is heated. Glass does not melt at all, but it softens. Only a crystal can melt; it has a definite melting point. On the contrary, when glass is heated, it goes gradually from the solid to the liquid condition. The softening is so slow that the glass is deformed appreciably only under a load. Then it grows softer and softer until it deforms under its own weight, and then begins actually to flow and at length it is as soft as it can be made at the flame temperature. The glass possesses, therefore, in contrast to crystals, no melting point and no melting temperature but only a softening range which stretches over several hundred degrees Centigrade.

We can speak of a definite softening temperature if we state the condition under which this temperature shall be selected, and what particular evidence of softening of the glass shall indicate this temperature. An example is the so called cohesion temperature, or the sintering point mentioned by Zschimmer. Even so, the location of this temperature point depends upon the conditions of the experiment, such as the rate at which heat is applied, the loading, the size of the grains, etc.

Another confusion in concept arises in the word "cooling" (Kuhlen) (English—"annealing"). By "cooling" or "cooling off" the glass we understand principally the whole procedure by which the finished glass article in a cooling oven (leer) or otherwise is brought from its high temperature, which it possessed after being made, to room temperature. By this means the glass article is not always rendered free from strain; for with simple "cooling" this is usually not accomplished, because the glass body arrives in the leer at such a low temperature or with such an unequal temperature distribution that with a gradual, simple cooling a true annealing of the glass is not brought about. In order to attain this, the glass article must have a special heat treatment in the annealing over which brings it to a definite, regular temperature at which it remains for some time and from which it is cooled to a minimum temperature at a definite rate in order to become free from strain. This process should not be designated "cooling" but rather "annealing" and should, therefore, not be said to occur in a cooling oven but in an annealing zone and not by way of a cooling curve but with a curve of release of strain.

When this zone has been passed through, the glass can be cooled as rapidly as may be. Since, however, the main idea is annealing, the whole process should have a name relating not to cooling, but rather to annealing or release of strain.

Another vague expression is the word "impurity" of raw material. The principal thing in mind is undoubtedly the iron content, but this is important only for colorless glass, whereas in some glass, iron is desirable in the raw material. As we look through the literature, we see other items about impurities. In sand, for example, we find also alumina, feldspar, and clay; but this is not quite true because, in certain glasses, we expect an alumina content, and some feldspar. In potash there are some potassium chloride and potassium sulfate, and some sodium salts designated as impurities, but for certain glasses potash can stand these "impurities". In lime, we find alumina, silica, and magnesia, but, again, in some glasses marl is preferred, which contains these impurities in high proportions.

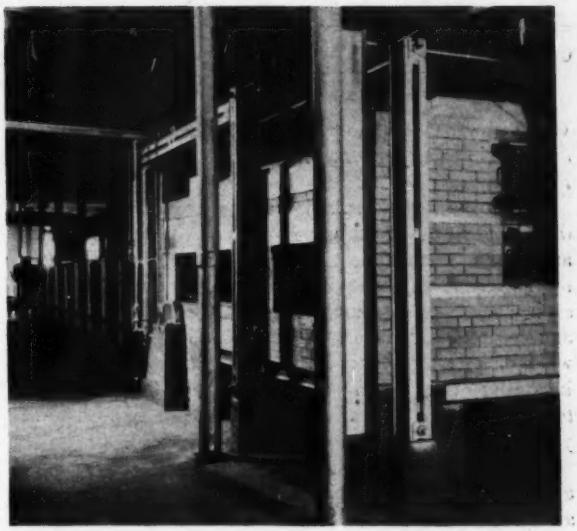
It is apparent from these examples, that the idea of an impurity is rather indefinite and must be specified for each branch of the glass industry. A lime which may contain considerable magnesia is not necessarily contaminated, and if it is iron-free, it can be used for nearly any variety of glass. Magnesia is, therefore, not an impurity but a constituent of the lime. Actual impurities are found only in artifically prepared raw materials upon whose purity we place high requirements, such as, soda, potash, borax, salt peter, litharge, and the like, while raw natural materials contain only *constituents* which admittedly for this or that glass may not be wanted. In artificial raw materials, impurities can be prevented by selection of the minerals from which they are made and proper care in their processing and preparation, but in the natural materials the other constituents may be said to belong; and, as we have said, may be regarded only as constituents.

These few examples might be added to, at will. We might mention the serious lack of definite concept in the term "hard glass" and the still worse one, the "hardness of glasses"; whereas, anyone who has anything to do with glass understands something else by the term hardness. There is similar confusion in the word "crystal", which is applied to all sorts of glasses, whereas essentially it should be used only for potash glasses where it is applied in connection with true lead crystal.

So long as there was no literature of glass, these confusions in words and ideas made little difference, but with the development of our modern literature, it would be well to take them into consideration so that we may arrive at definite forms of expression.

ZIRCON IN THE GLASS INDUSTRY

Recently off the presses is *Foote-Prints* for Dec. 1936, semi-annually issued house magazine of the Foote Mineral Co., Philadelphia. Of greatest interest to glass men is an article entitled "Zircon as a Ceramic Material." To quote the findings of George C. Betz, Ceramic Engineer of the company on the application of $ZrSiO_4$ in the glass industry:—



● *Following up the article in the January* GLASS INDUSTRY *on the new type of pressed glassware made from cullet by the Mississippi Glass Co., there is illustrated here the combination bending and annealing furnace made by the Amsler-Morton Co. for this process. To quote from Amsler-Morton's letter, "The bending furnace contains a flat wheel which rotates through two heating zones, the top of the wheel having a refractory cover on which moulds for the glass are set. After the moulds are red hot, the glass is then placed on it cold; and the weight of the glass, in most cases, under the heat allows it to take the form of the moulds. It is then removed from the mould by the operator, and placed on the annealing lehr belt which is a continuation of the bending furnace. The lehrs are shown at the extreme left, and the combination furnace appears in the foreground.*

"The effect of the addition of zirconia to glass has received the attention of a great many investigators. Most of the references available on this subject seem to agree that zirconia renders the glass less sensitive to sudden temperature changes. It is also a generally accepted fact that additions of zirconia increase the resistance of the resulting glass to hydrochloric, nitric and sulphuric acids as well as to caustic soda.

"Although chemically refined zirconia has been preferred in the past for glass manufacturing purposes because of its extremely low iron content, it would seem advantageous to consider the use of the highly purified zircon sand now available, except in such applications where even a very small percentage of iron would be detrimental.

"Transparent as well as opalescent glasses have been produced containing as much as 12 per cent zircon. Glasses of this type have a high density, high viscosity and are usually quick setting. Probably the most desirable characteristic imparted to glass by the addition of zircon is the increased chemical stability and resistance to the destructive effects of weathering agents.

"The function of zirconia in glass is more or less analogus to alumina and in some respects, zirconia is considered superior to alumina. Horak and Sharp* report that the substitution of alumina by zirconia increased the chemical durability of borosilicate glasses and that the modulus of elasticity of soda lime glasses was reduced by replacing a small percentage of calcium oxide by zirconia."

* "Notes on the Effect of Zirconia on the Chemical Durability of Some Borosilicate-Lime Glasses," Horak and Sharp, Jour. Am. Cer. Soc., 1935, 9.

Review of "IL VETRO"

● *A three volume work by Professor Corrado Rovini of the University of Pisa. Published by U. Giardini, Pisa, Italy.*

We presume that this work has been compiled for the purpose of encouraging the Italian glass industry and making accessible to the Italian people references to the extensive literature in other languages. In any such work there is room for a great deal of uncertainty and error of judgment as to what is to be included and what omitted. We trust that it may serve its purpose in Italian, as Hodkin and Cousens text-book of glass technology on a less ambitious scale did in English some years ago.

The first section of the first volume, to the extent of about 80 pages, is occupied with a brief discussion of glassmaking up to the year 1900. This part is interesting, inasmuch as more attention is given to the Italian developments of the art than in English treatises, while the developments in America are dismissed with three short paragraphs, and apparently the period from 1800 to 1900 is regarded as a complete blank. This is rather a refreshing attitude and it does perhaps serve to bring out the fact that up to the end of the last century, the history of glassmaking was mainly written abroad, and the American development of consequence has been largely confined to the present twentieth century.

The second part of the first section deals with the more recent history of glassmaking, and in particular with mechanical developments.

In the third part of this first section are given some statistics on the importance of the industry in various countries, and the organization of the industry therein. The present reviewer, being familiar principally with the American industry, naturally turned to those pages and is unable to make much sense of them. Such matters as are mentioned seem to be of trivial importance, and the things of consequence are omitted.

The second part of the first volume—which is really equivalent to a separate volume bound along with the first, beginning at page 231—deals with batch materials or glass-forming oxides. It considers in a good deal more detail than American textbooks the use of various naturally occurring minerals, such as are being exploited in the Soviet Republic and elsewhere. In the ultimate analysis, all our glass-forming materials originate in naturally occurring minerals, but in the United States we are in the somewhat fortunate position of being able to obtain them in a comparatively simple and usually in a rather pure form. The circumstances do not always apply abroad, in fact rarely do so, and the possibility of using complicated rocks involving many minerals, or minerals with a substantial amount of impurity, have to be investigated.

This section of the work deals with the purification of impure raw materials and with the production of glass-forming chemicals from their raw materials. It deals also with reactions occurring in the tank itself, and devotes some pages to coloring and decolorising oxides and opacifying media.

The third division of this volume, beginning on page 347, deals with the constitution and limits of composition of commercial glasses, explaining the use of triaxial diagrams, the areas mapped out by Gelstharp & Parkinson, and the devitrification diagram of Morey and Bowen. It deals also with the calculation of the glass composition of the batch and continues somewhat abruptly with the mechanical properties of hardened or tempered glass, like Securit.

Volume II

Chapter IV deals with a number of the physical properties of glass, the viscosity, such mechanical properties as density, strength under tension, compression, and flexure, the modulus of elasticity, hardness, and so forth. The thermal, optical and electrical properties are next reviewed, and finally the literature on the chemical resistance of glass. Chapter V deals with melting, devitrification, annealing, hardening, and so forth, and finishes up with some discussion of defects in glass, nature and constitution of the vitreous state. Chapter VI is a brief review of about twenty pages on refractories, while Chapter VII deals with the processes of combustion and so forth. Beyond this, in Chapter VII, we leave the physical properties of glass, as such, and begin to deal with gas producers and similar engineering matters.

Volume III

Volume III of the series begins with Section 9 of the text, which is a long section dealing with the important matter of the construction and operation of furnaces and regenerators and so forth. Except for Dralle-Keppelar this is perhaps the most extensive text in any language on glass tanks as such. The next section, No. 10, continues with the engineering data and discusses the manufacture of glass, particularly in so far as it is done by machinery. Thus we get quite a discussion on Fourcault tanks, Fourcault drawing machines, the Colburn process, and the processes of manufacturing plate glass, including the grinding and polishing. There follows a description of a number of bottle-making machines, with some reference to their processes of evolution, although this has been already touched upon earlier in the work. We here find a description of a number of machines which are not well known in the United States. Section 11 is a short chapter of 40 pages dealing with refractory materials in a somewhat superficial manner, while section 12, almost equally short, deals briefly with optical glass and laboratory ware.

The work seems to be a little more critical than some of the recent publications in the French language, but necessarily it is impossible for any single author to review with a discriminating precision the vast amount of literature on the physical properties of glass and its constitution, which have appeared in recent years. There are too many loose ends and contradictions to be thoroughly disentangled at the present time, and although the book under review is dated 1935, it already seems several years out of date.

Scattered here and there throughout the book, at the end of chapters, are somewhat extensive bibliographies which should help Italian students materially in tracking down the literature upon the subject, but the author does not appear to have reached any clear and thoroughly discriminating point of view of his own in the general body of the text.—F.W.P.

PUBLICATIONS RECEIVED

Plate Glass. Report No. 110, Second series. United States Tariff Commission, Washington, D. C.

A complete treatment of American exports and imports of plate glass is contained in this bulletin. An interesting feature is a listing of the rates on plate glass specified in the Tariff Act of 1930 and those effective since May 1, 1935, as a result of the Belgian trade agreement. Included is a treatment of the relationship between the various changes in tariff laws and the trade in plate glass. Copies may be obtained from the Superintendent of Documents, Washington, D. C., for Five Cents each.

Minerals Yearbook, 1936. United States Bureau of Mines, Department of the Interior, Washington, D. C.

This volume contains 69 chapters, 154 illustrations, 1,136 pages and provides in convenient form a comprehensive and accurate record of economic developments and trends in the mineral industries of the United States during 1935. In passing, it should be noted that the mineral production of the United States in 1935 was valued at $3,688,000,000 an increase of nearly 11 per cent from the $3,325,100,000 in 1934.

In addition to presenting the fundamental statistics of the production and marketing of a hundred commercial minerals, world production of minerals and economics of international mineral policies are reviewed.

The 1936 edition, in cloth binding, is for sale by the Superintendent of Documents, Government Printing Office, Washington, D. C., at $2.00 per copy.

The Kyanite Industry of Georgia. By Richard W. Smith. Technical Publication No. 742. The American Institute of Mining and Metallurgical Engineers, 29 W. 39th St., New York City.

Kyanite, long known to occur in Georgia, did not excite commercial interest until about 1930, but since then the industry has grown considerably, the principle market for Georgia kyanite at present being for refractories used in the manufacture of glass. This publication treats the geology, origin, mining and milling, and predicts something of the future of kyanite.

Young's Modulus of Elasticity, Strength, and Extensibility of Refractories in Tension. By R. A. Heindl and L. E. Mong. Research Paper RP923. National Bureau of Standards, Department of Commerce, Washington.

The above properties were investigated for 16 brands of fire-clay brick with a wide range in silica content, representing the stiff-mud, dry-press and hand made methods of forming. The effects of method of setting the bricks in the kiln during firing, and weight of brick on the tensile properties of fire-clay brick made by the dry-press process were briefly studied.

A Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers. By Frederick G. Straub. Bulletin No. 283, Engineering Experiment Station, University of Illinois, Urbana, Ill.

This bulletin describes a study of various methods of chemical treatment which might be used to prevent various types of scale which form in steam boilers.

The System Lime-Boric Oxide-Silica. By E. P. Flint and Lansing S. Wells. Research Paper RP941. National Bureau of Standards, Department of Commerce, Washington, D. C.

The equilibrium diagram for the system CaO-B_2O_3-SiO_2 constructed from data on 200 ternary compositions, is presented. The portion of the diagram immediately adjacent to the binary system B_2O_3-SiO_2 is incomplete. A unique feature of the system is the appearance of an area of liquid immiscibility extending across the diagram from the lime-silica side to the lime-boric oxide side and crossing the fields of silica, monocalcium borate, and calcium diborate. A newly established ternary compound, $5CaO$-B_2O_3-SiO_2, melts congruently at 1,419° C. Tricalcium silicate does not appear at the liquidus in the ternary system. Dicalcium silicate forms partial solid solutions with calcium borates whereby the α-β inversion temperature is lowered by a maximum of 190° C.

Perspective and Optical Illusions of Depth. By Theodore M. Edison, research engineer, Calibron Products, Inc., West Orange, N. J. The Calibron Notebook, No. 3, May 1936.

The first section of this paper deals with gauges of depth and includes several striking optical illusions. The more technical perspective methods section starts with an historical note and comprises treatments of direct projection, vanishing and measuring point projection, conversion factor constructions, the use of charts, and mechanical, optical and photographic perspective drawing aids. The third section is devoted to object-observer-picture plane relationships, perspective rectification and its uses, curved objects and shadows, and aerial mapping. Notes on projection systems, a comparison chart of perspective methods, and a key to terms and symbols are included.

Report on the Works Program. Works Progress Administration. March 16, 1936.

Some interesting facts about putting 3,000,000 unemployed to work and assisting 289,000 young people of high school and college age to continue their studies. 5,300 schools were built or repaired, 4,200 public buildings were erected or repaired, 5,000 parks and playgrounds constructed and improved, 6,300 water and sewer systems were built or repaired, 3,000 projects for flood and erosion control are under construction, 328 air port projects are under construction and 130 electric utilities systems were installed or repaired. Under construction are projects valued at $160,000,000 to provide improved roads for millions of farmers. Regardless of politics, this publication is an interesting record of a stupendous effort.

The System K_2O-PbO-SiO_2. By R. F. Geller and E. N. Bunting. Research Paper RP911. National Bureau of Standards, Department of Commerce, Washington, D. C.

The system was investigated by means of well known methods involving quenching, petrographic examination, and heating curves. Five ternary compounds were identified by optical properties and the chemical composition of four of these were established. A number of melts were studied also as glasses to obtain data of interest to manufacturers of glasses, glazes and enamels.

CURRENT PRICES OF GLASS-MAKING MATERIALS

FURNISHED BY PRODUCERS, MANUFACTURERS AND DEALERS

Base Materials

		Carlots	Less Carlots
Barium carbonate ($BaCO_3$), Crude, (Witherite)			
90%, 99% through 200 mesh	ton	40.00	45.00
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f. o. b. shipping point	ton	15.00-16.00	18.00
Borax ($Na_2B_4O_7 10H_2O$	lb.	...	...
Granulated	In bags, lb.	.020	.0245-.027
Powdered	In bags, lb.	.0225	.027-.0295
Boric acid (H_3BO_3) granulated	In bags, lb.	.0475	.0525-.055
Calcium phosphate ($Ca_3(PO_4)_2$)	lb.	.07	.07½
Cryolite (Na_3AlF_6) Natural Greenland (Kryolith)	lb.	.08¼	.09
Synthetic (Artificial)	lb.	.08¼	.09
Feldspar—			
20 mesh	ton	11.00-13.25	
40 mesh	ton	11.50-13.75	
Granular	ton	11.75-14.00	
Semi-granular	ton	11.00-13.25	
L. C. L., (Min. 2 tons) $3.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f. o. b. mines	ton	31.50	...
In bags	ton	33.10	38.00-40.60
Kryolith (see Cryolite)			
Lead Oxide (Pb_3O_4) (red lead) (N. Y.)	lb.	.085	...
In 5 Ton lots	lb.	...	.09
Less than 5 Tons	lb.	...	.095
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	10.50	...
Burnt (CaO) ground, in bulk	ton	7.00	...
Burnt, ground, in paper sacks	ton	9.00	...
Burnt, ground, in 280 lb bbls.	Per bbl.	2.25	2.25
Calcined (K_2CO_3) 96-98%	lb.	.06⅞	.07¾
Hydrated 80-85%	lb.	.06	.06¼-.06⅜
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	27.00
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat Per 100 lb.	95	...
In barrels	Per 100 lb.	1.35	...
In bags	Per 100 lb.	1.10	...
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	Per 100 lb.	...	2.25-2.65
95% and 97%			
Bulk	Per 100 lb.	1.275	...
200 lb. bags		1.34	1.39
100 lb. bags		1.375	1.425

Special Materials

		Carlots	Less Carlots
Aluminum hydrate ($Al(OH)_3$)	lb.	...	.04
Aluminum oxide (Al_2O_3)	lb.	.04	.05
Antimony oxide (Sb_2O_3)	lb.	...	.14¼
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.03	.03¼
Barium nitrate ($Ba(No_3)_2$)	lb.	...	.07¾
Rutile (TiO_2) powdered, 95%	lb.	.10-.12	.13-.15
Sodium fluosilicate (Na_2SiF_6)	lb.	.06½	.0725
Tin Oxide (SnO_2) in bbls.	lb.	...	.55
Zinc oxide (ZnO)			
American process, Bags	lb.	.05¾	.05½
White Seal, 150 lb. bbls.	lb.	.07	.07¼
Green Seal bags	lb.	.06¾	.06½
Domestic White Seal bags	lb.	.06¾	.07
Red Seal, bags	lb.	.05¾	.06
Zircon			
Granular (Milled .005-.2c higher)		.07	.67½-.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04-.05

Coloring Materials

		Carlots	Less Carlots
Barium selenite ($BaSeO_3$)	lb.	...	1.50-1.75
(Commercial, 25% Selenium)	lb.	...	.90
Cadmium sulphide (CdS)	lb.	...	.90-.95
Chromite	lb.	...	.0215
Cerium hydrate			
100 lb. drums and 600 lb. barrels	lb.	...	.60
Chrome Oxide Green, 400 lb. bbls.	lb.	...	.20-.25
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	...	1.41
In 10 lb. tins	lb.	...	1.51
Copper oxide			
Red (Cu_2O)	lb.	...	.20
Black (CuO)	lb.	...	.18¼
Black prepared	lb.	...	.22
Iron Oxide—			
Red (Fe_2O_3)	lb.	...	.0425
Black (Fe_3O_4)	lb.	.04½	...
Iron chromate	lb.	...	.035-.05
Lead chromate ($PbCrO_4$)	lb.	...	.16
Manganese, Black Oxide			
In Paper bags	ton	47.50	50.50
In Burlap bags	ton	49.50	52.50-57.50
In Casks	ton	51.50	54.50-59.50
Neodymidm oxalate, 50 lb. drums	lb.	...	$3.00
Nickel oxide (Ni_2O_3), black	lb.	...	.35-.40
Nickel monoxide (NiO), green	lb.	...	.35-.40
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	...	.09
Powdered	lb.	...	.09½
Potassium Chromate (K_2CrO_4) 100 lb. kegs	lb.	...	.27
Powder blue	lb.	...	.18¾-.19¼
Rare earth hydrate			
100 lb. drums	lb.	...	.35
325 lb. barrels	lb.	...	.30
Selenium (Se) In 100 lb. lots	lb.	...	2.00
In lesser quantities	lb.	...	2.10
Sodium bichromate (Na_2Cr_2O7)	lb.	.06½	.07
Sodium chromate (Na_2CrO_4) Anhydrous	lb.	...	.08¼
Sodium selenite (Na_2SeO_3)	lb.	...	1.80-2.00
Sodium uranate (Na_2UO_4) Orange	lb.	...	1.50-1.55
Yellow	lb.	...	1.50-1.55
Sodium uranyl carbonate	lb.	...	.80-.90
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.70-4.10
Flowers, in bags	Per 100 lb.	3.00	3.35-3.75
Flour, heavy, in 250 lb. bbls.	Per 100 lb.	2.90	3.25-3.65
Uranium oxide (UO_3) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	2.25
Yellow orange	lb.	...	1.50

EQUIPMENT AND SUPPLIES

TESTING SIEVE SHAKER

For testing fine materials, the Newark Wire Cloth Co., Newark, N. J., has recently introduced a new "End-Shak" testing sieve shaker. It is provided with a simplified hold-down device, which permits the sieves to be easily and quickly put in place and removed. An outstanding feature is said to be the achievement of a combined reciprocating and turning motion. In the development of this machine, the company advises that a special effort has been made to eliminate sudden jarring movements and to maintain a constant turning of the sieve (one complete revolution each minute) at all times thus reaching an end-point test in as few minutes as possible.

The entire machine weighs 145 lbs., including the motor and auto time switch. The shipping weight is 175 pounds. It is 32 inches high. The base, overall, is 22 by 18 inches. A standard ¼ h.p. motor is used; 110 and 220 volt; 60 cycle alternating current; 1750 r.p.m. The standard auto time switch which goes with each machine automatically controls the period of the test. The "End-Shak" is designed for 8 inch diameter testing sieves, and is adjustable to hold any number of sieves from one to 13 inclusive.

COMPACT STRAIN DETECTOR

Gaertner Scientific Corporation, Chicago, has recently developed a portable strain detector which folds to fit into a compact leather carrying case measuring 16½ x 9½ x 2 inches. It may be set up in a few minutes and the cord plugged into 110 volt socket, after which the instrument is ready for use. The detector is only 27 inches long when set up and has a capacity for large pieces including plates up to 14 inches diameter, glass tubes up to 5 inches diameter of any length, bottles and flasks of one gallon capacity.

The detector constructed of sheet steel with rubberized cloth curtains to exclude extraneous light makes it possible to use the instrument in a completely lighted room. Light from a built-in 50 watt tubular bulb and reflector is diffused by a ground glass and polarized by reflection from a 6-inch blackened concave mirror. The specimens are held in the hand and inserted under the curtains into the patch of the polarized light. They are viewed through an analyzing eyepiece equipped with a Nicol prism and a selenite retarding plate.

The company points out that since the eyepiece contains no lenses, the specimens appear in their natural size and form. The strains are said to be strikingly and unmistakably evidenced by brilliant colored bands.

NEW INSULATING BRICK

A new type of 2000-degree insulating brick, known as "JM-20," has recently been placed on the market by the Johns-Manville Corporation, New York. This brick has been developed by the company's research laboratories for use behind refractory walls in various types of high temperature industrial equipment, including boiler settings, ceramic kilns, steel plant equipment and practically all types of furnaces. It can also be used for direct exposure at temperatures up to 2000-degrees F. wherever there is no flame impingement, slag action or mechanical abrasion. It is unusually light in weight, weighing less than 1.7 pounds per standard 9-inch equivalent, and it is said that its heat capacity is less than one quarter that of ordinary refractories, and its thermal conductivity one sixth that of fire brick.

SPRAYING MACHINE

Another new development in the design of spraying machines has just been completed by O. Hommel Co., Pittsburgh. The main feature of this new spray gun is its nozzle which is provided with a double air jet in its fangs, instead of the customary single jet holes. This construction is said to increase the speed and efficiency of the spray gun, permitting a wider fan of spray and complete atomization of the material, yet requiring a lower pressure and volume of air. Production tests show this new type nozzle to give 25 per cent greater speed at a 15 pound pressure and also to eliminate "splitting" at edge of spray fan.

● *Illustrated at the left is the Gaertner portable strain detector, which is said to fold up to fit in a brief case.*

PORTABLE pH METER

A new portable pH meter has recently been introduced by Thwing-Albert Instrument Co., Philadelphia. There are two models: Model 1 is a simple potentiometric circuit with quinhydrone, or antimony electrodes or both. Model 2 is a vacuum tube type with quinhydrone, antimony or glass electrodes. Model 1 can easily be converted into Model 2 at any time. Both models are direct reading in pH measurement and can be used even by a non-technical person. These instruments are said to be especially adapted to potentiometric titrations and their operation is entirely independent of color, turbity or suspended matter in solutions.

The Precision Scientific Instrument Co., 1730 North Springfield Ave., Chicago, have advised that they are now the sole manufacturers of Freas and Thelco constant temperature laboratory equipment, which was formerly built and sold by the Freas Electric Co., Irvington, N. J., and Chicago.

CATALOGS RECEIVED

Multi-Pointer Gages. Bulletin No. 163. Bailey Meter Co., Cleveland. A new catalog introducing the new Bailey diaphragm-operated multi-point gage which has been developed for boiler room service. These units are available in casings containing from one to 12 units, and may be surface, semi-flush or full flush mounted.

Rockwood Pivoted Motor Drives. Bulletin No. 29. Rockwood Manufacturing Co., Indianapolis. The current issue of this house organ to the company's salesmen contains some interesting photographs of installations of this machinery in two of the plants of the Owens-Illinois Glass Co.

Duplex Power Pumps. Bulletin No. 6160. Fairbanks-Morse & Co., 900 South Wabash Ave., Chicago. A colorful and fully illustrated catalog describing the features and applications of these duplex power pumps with self-oiling power ends and valve deck type fluid ends.

Magnetic Hand Book. Sterns Magnetic Manufacturing Co., Milwaukee. A new loose-leaf manual comprising 170 pages of technical data, illustrations and descriptions of the various phases of magnetic engineering. Methods of suspended magnet application are also included.

DECEMBER PLATE GLASS PRODUCTION

The Plate Glass Manufacturers of America have announced that the production of polished plate glass by its member companies in Dec. 1936, was 7,371,326 square feet as compared to 13,083,963 square feet produced in November. This makes a total of 198,068,838 square feet produced by these companies during 1936 as compared to 179,816,459 square feet in 1935.

BEER BOTTLE PRODUCTION DOUBLED IN 1936

Production of bottles for malt beverages in 1936 doubled that for 1935, according to preliminary figures issued by E. G. Ackerman, secretary of the Glass Container Association. Final reports may show an even higher record of beer bottle production, but it is certain that the totals will be the highest since the first year of Repeal, when large bottle replacements were made.

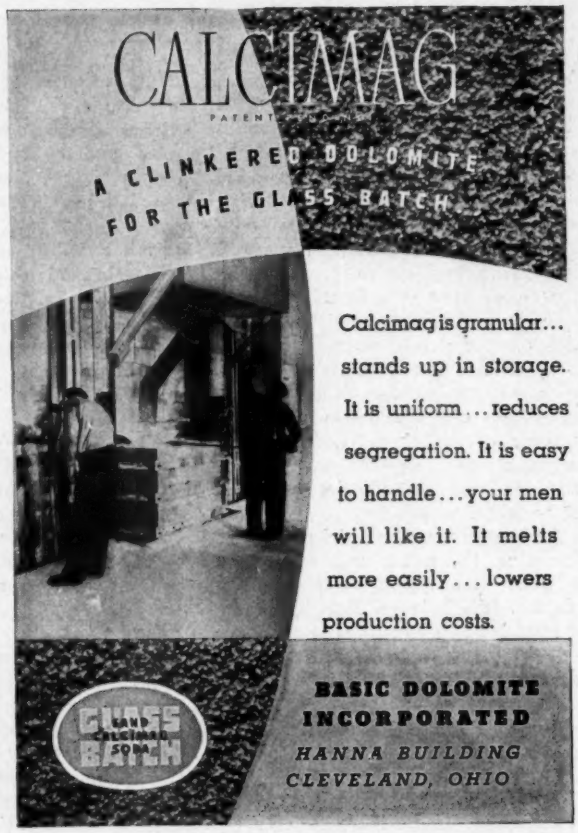
The new high level of beer bottle production is due both to the decided boom in bottled beer sales last year, and to the new types of beer bottle designs that have become popular during the year, Mr. Ackerman said. Not only has the total production of beer increased during 1936, but the proportion of bottled beer to draft beer has increased steadily, with the result that the actual number of barrels put into bottles jumped more than 40 per cent over the preceding twelve months.

The appearance of half a dozen popular new bottle designs, several of them one trip containers, also accounted for the increase in glass manufacture. Half-gallon bottles sold well, particularly during the summer. In many parts of the country from 15 to 20 per cent of the packaged beer now goes to market in quart bottles, whereas a year ago the use of both half-gallons and quarts was still in the experimental stages.

Furthermore, the two new light-weight, one-trip glass containers, the Stubby and the Steinie bottles, have found a wide acceptance. The latter, introduced during the first quarter of 1936, has already enrolled almost a quarter of the bottling brewers of the country.

A recent check-up of glass containers used by brewers showed the following:

Steinie Bottles, 12 ounce, adopted by 145 brewers.
Stubby Bottles, 12 ounce, in use by 63 brewers.
Steinie Quart, adopted by 21 brewers.
Steinie Half-Gallon, adopted by 10 brewers.
Standard Quart, used by 159 brewers.
Standard Half-Gallon, used by 125 brewers.
Standard Export Bottle, used by all 613 brewers.


CALCIMAG
A CLINKERED DOLOMITE
FOR THE GLASS BATCH
Calcimag is granular... stands up in storage. It is uniform... reduces segregation. It is easy to handle... your men will like it. It melts more easily... lowers production costs.
GLASS BATCH
BASIC DOLOMITE INCORPORATED
HANNA BUILDING
CLEVELAND, OHIO